Space Weather Technical Forecast

Issued on Thursday, 10 February 2022 at 12:25 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

---

Space Weather Forecast Headline: Slight chance of G1/Minor Storm on day 1 (10 Feb), then Chance of a G1 on day 3 (12 Feb) or on day 4 (13 Feb). Active electron fluence probably slowly declining. Chance of an M-class flare.

Analysis of Space Weather Activity over past 24 hours
Solar Activity: Solar activity has been low over the last 24 hours, with several C-class flares. The most energetic of these was a C5.7 at 09/1736 UTC from AR2939, a mature spot near the southwest limb which has faded somewhat since the flare. Two regions in the northern hemisphere, AR2941 and AR2940 are both large, but relatively magnetically simple, and now have the highest flare risk. The new region south of 2939 has been numbered AR2944, this is currently unipolar and weak. Another new unipolar region has developed in the southwest quadrant. No further Earth directed CMEs have been observed in available imagery.

Solar Wind / Geomagnetic Activity: The solar wind as measured by DSCOVR at L1 showed the arrival of a weak CME at 09/2010 UTC which left the Sun on 06 Feb. The wind speed was just below 400 km/s when the CME arrived and it increased to around 430 km/s, since varying between 390-440 km/s. The density increased from 2 ppcc to 9 ppcc and has continued to increase, peaking at 18 ppcc. The IMF jumped from 4 to 8nT, increasing further to peak at 12 nT. The north-south component, Bz, initially varied weakly but increased to vary between +9/-10 nT. Phi angle was negative (towards the Sun). Geomagnetic activity was Quiet (Kp 0-2), with two Unsettled (Kp 3) intervals 10/0000-0600 UTC.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) measured at GOES 16 was at background levels. The high energy electron flux (greater than 2MeV) was above the high threshold, peaking at 1.02e4 pfu at 09/1550 UTC, but fell to mainly moderate levels between 10/0315-0935 UTC before reaching high again. Electron fluence values are above the Active (1e8 integrated pfu) threshold on a slight declining trend, reaching 4.95e8 integrated pfu at 09/2359 UTC.

Four-Day Space Weather Forecast Summary
Solar Activity: Solar activity is forecast to remain low through the next four days, with a chance of an isolated M-class flare, mainly from AR2940 and AR2941.

Solar Wind / Geomagnetic Activity: A CME which left the Sun on 06 February arrived at 09/2010UTC, though it is a weak feature. Continuing weak CME effects are likely through the next 24 hours. The high speed stream from coronal hole 53 is then expected to give wind speeds around 600 km/s on day 3 (12 Feb) or on day 4 (13 Feb). Geomagnetic activity is expected to start Quiet to Active with a Slight Chance of G1/Minor Storms, with residual effects of this CME possible into day 2 (11 Feb). Mainly Quiet activity thereafter until day 3, when the high speed stream will likely give Unsettled to Active conditions with a chance of G1/Minor Storm on Days 3 and 4.

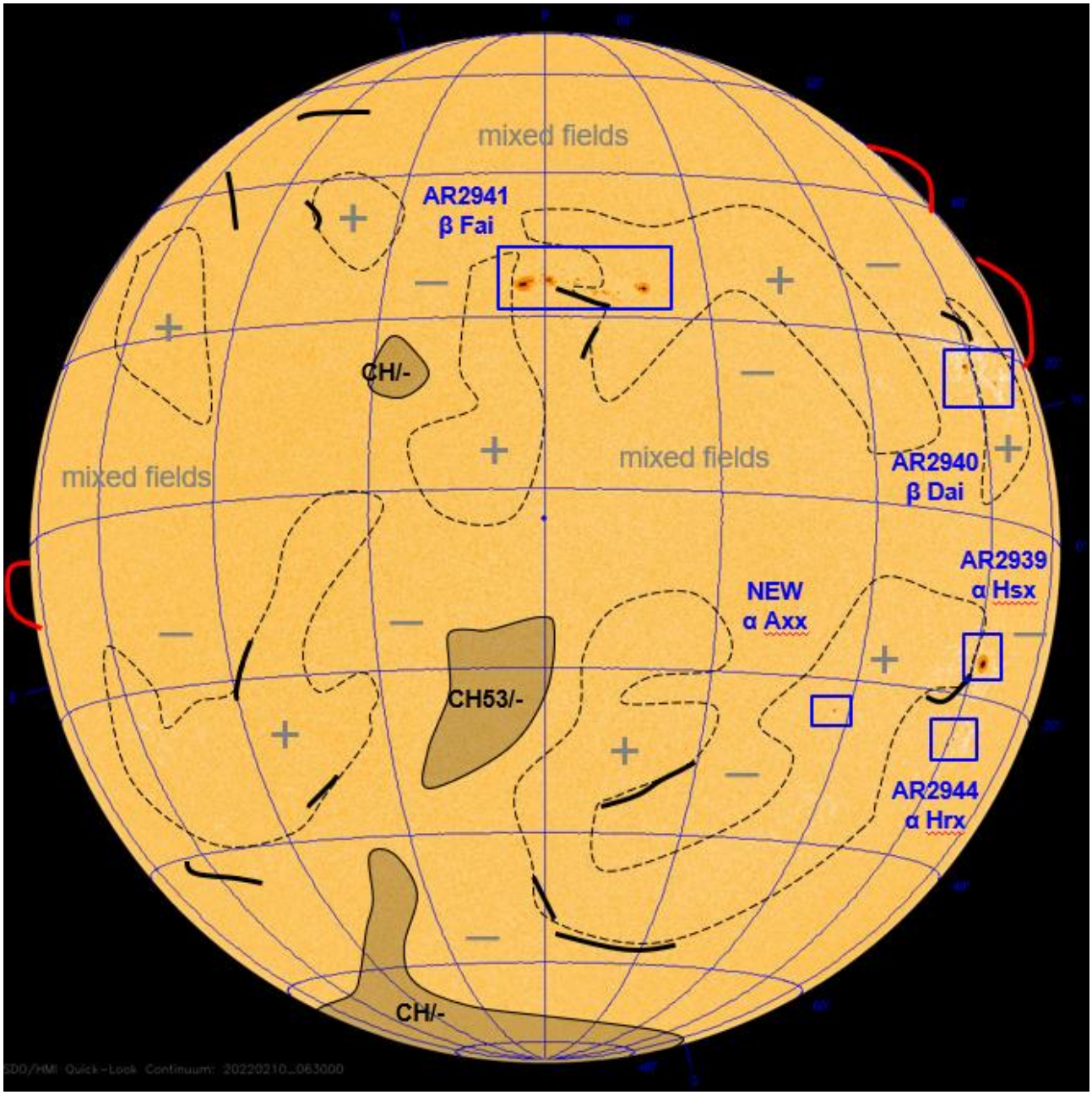
Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is forecast to be at background levels, but with a slight chance of rising close to, or just above, the

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

S1 level given any significant flares. High energy electron flux is expected to be lower than previous days due to CME effects, although it is still above the High threshold. The CME effects give low confidence to the subsequent forecast, but a decline in Active (1e8 integrated pfu) electron fluence levels is probable, however the level of the decline is difficult to assess at the present time.

Figure 1. Solar Analysis Valid 10/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

Met Office Space Weather Technical Forecast

Geomagnetic Storms:

A CME which left the Sun on the 6th February arrived at 09/2010 UTC as a very weak feature. CME effects are continuing with a gradual increase in the magnetic field, and effects are likely to only slowly wane over the next 24 hours. That said, so far geomagnetic response has been muted but G1/Minor Storm can't be ruled out in any prolonged periods of negative Bz.
The next feature of interest will be the high speed stream from coronal hole 53, which looks set to arrive either on day 3 (12 Feb) or on day 4 (13 Feb), with peak of around or just above 600km/s, based on persistence from this recurrent feature.

Geomagnetic activity is expected to start Quiet to Active with a Slight Chance of G1/Minor Storms in any prolonged negative Bz. Residual effects of this CME are possible into day 2 (11 Feb), this is dependent on the post-shock magnetic sheath. The onset of the high speed stream from the equivalent of coronal hole 53 generated G1/Minor Storms on the last rotation, with the chance of a similar effect this time on day 3 or on day 4.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	20	10	40	40
Strong	G3	No	1	1	5	5
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

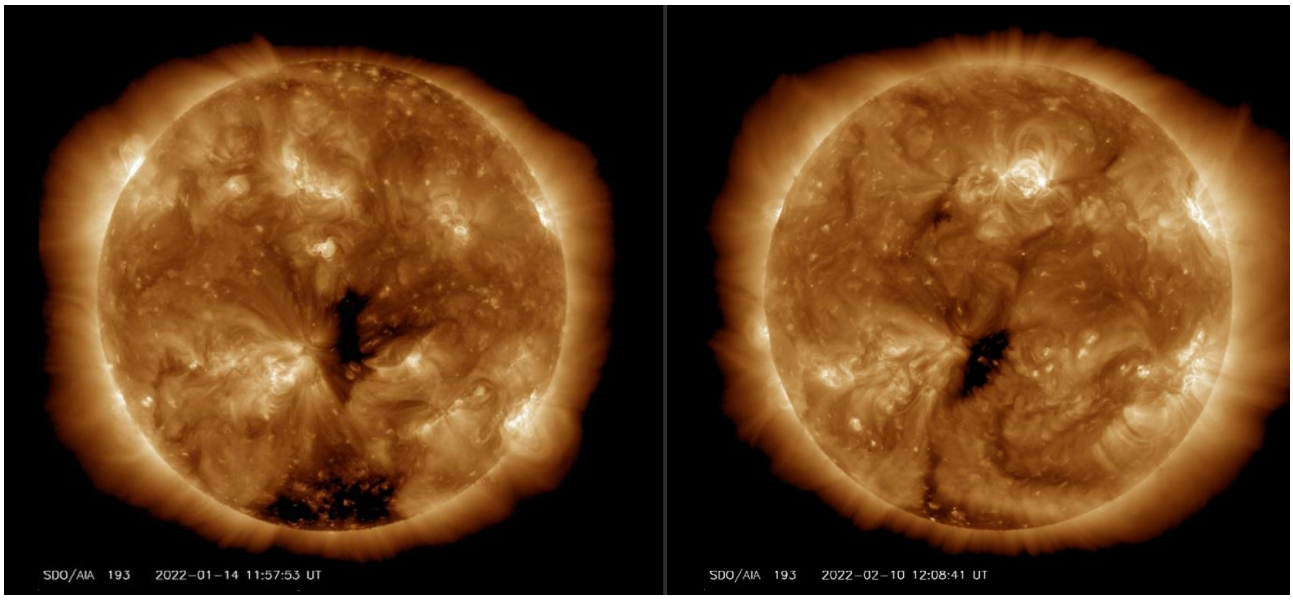
Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
*	*	*	*	*	*	*

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

Figure 2: AIA-193 imagery showing coronal hole 53 on this rotation (right) and the equivalent position on the previous rotation (left). It appears to be a little behind on this rotation, suggesting a slightly later arrival than would be suggested by the arrival time on the previous rotation.



Radio Blackouts - X-Ray Flares:

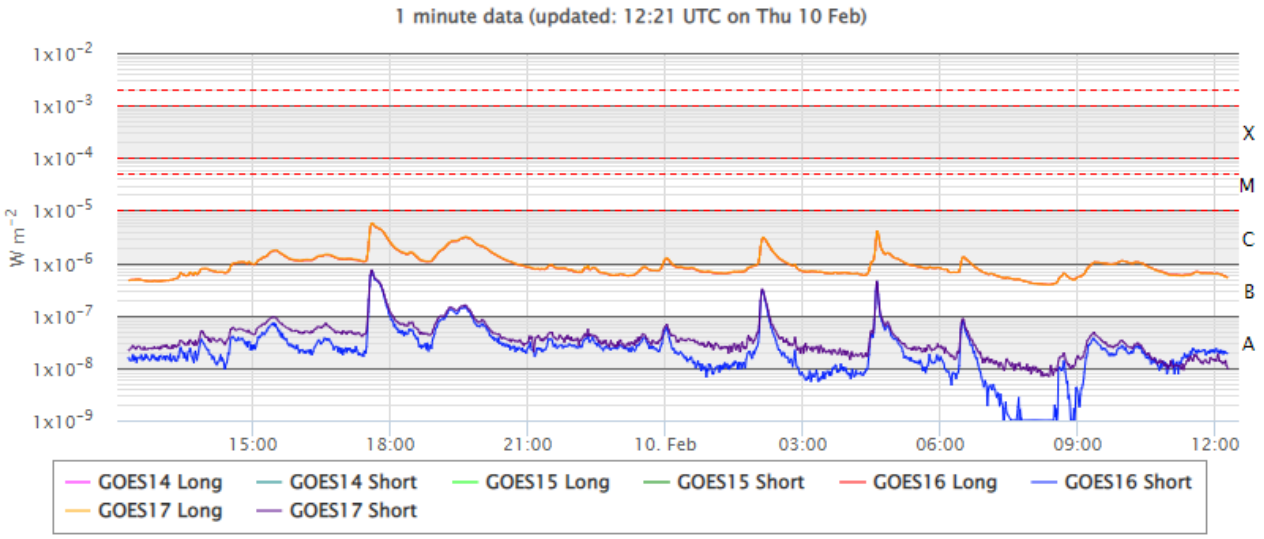
There are currently five sunspot regions on the visible disc. 2941 (Fai/Beta) is the largest region, with several intermediate spots in evidence, but is also relatively magnetically simple. 2940 (Dai/Beta) seems to be relatively stable but is also becoming difficult to classify as it approaches the west limb. 2939, from where the 06 February CME emanated, produced a C5.7 flare on the 9th Feb. However, the trailing spots have since faded and it has been re-classified as Hsx/Alpha. As such any flare risk associated with this region has reduced. 2943 has faded. Two new regions have developed in the southwest quadrant, both unipolar, one of which has been numbered 2944 (Hrx/Alpha). The other is currently Axx/Alpha.
Solar activity is expected to be mainly low, with C-class flaring continuing. There is a chance of an M-class flare through the next 4 days.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	30	30	30	30
Very Active	R3 to R5 X Class	No	2	2	2	2

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

Figure 3: X-ray flare trace showing several C-class flares in the last 24 hours.



Solar Radiation Storms - (High Energy Protons):

The high energy proton flux, as measured by GOES-16 is at background levels. Solar radiation storms are unlikely in the period. However, there is a very slight chance for proton fluxes to rise given any significant flaring from AR2940 and now from AR2941, as they continue to transit across the western hemisphere.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

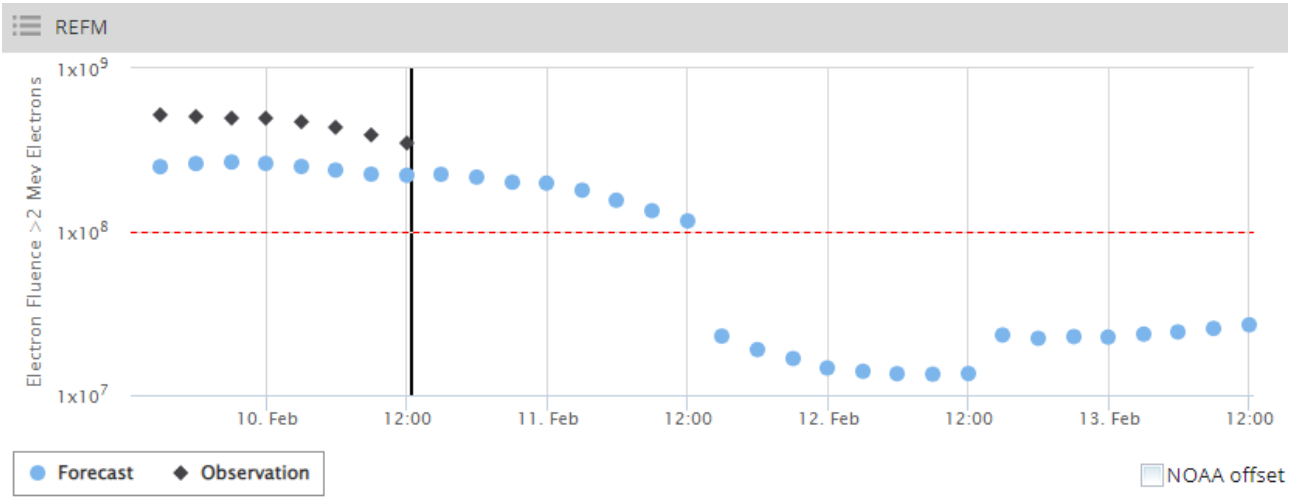
Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

High Energy Electrons Event (≥ 2MeV):
High energy electron flux (greater than 2MeV) has returned to high (>1e3pfu) levels after a fall overnight for the first time in several days due to a weak CME arrival. It is likely that peak levels will be lower than previous days. Following this CME arrival confidence in the behaviour of the electron flux decreases, as this depends on the extent of any initial suppression caused by the CME arrival, and also on the level of charging that may then occur due to CME effects. It seems probable that levels will be lower than previous days, but this is low confidence.
24-hour fluence values are expected to remain above the Active (1e8 integrated pfu) threshold through day 1 (10 Feb), but on a declining trend. Thereafter it is likely that there will be a continuation in the decline, at least for the first couple of days, but a recovery is possible later. The probabilities represent the uncertainty in the level of decline and then the speed of any recovery.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	Yes	100	80	50	50
Very Active	≥ 2 MeV ≥ $1x10^9$	No	5	2	1	1

Figure 4: REFM model suggesting a sharp decline in fluence levels. This is likely to be too fast in reducing the fluence.



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.